Structural Practices

practical knowledge beyond the textbook

Becoming a Results-Oriented Structural Engineer

Part 1: Technical Skills

By John P. Miller, P.E., S.E.

John P. Miller, P.E., S.E. is a Principal with KPFF Consulting Engineers, St. Louis, MO. He may be contacted at **john.miller@kpff-stl.com**.

As newly minted structural engineers, we were all eager to get settled in with our employer and get to work crunching numbers and working on projects. This is great – every firm needs fresh young talent for many reasons. Most young engineers tend to be task-oriented, whose metrics might include: How many hours did I work this week? Was my day filled with productive work? Did I complete my assignment on time? Was the input data on my structural model correct? Did I learn something new today?

As younger engineers grow and become more experienced in their field, some will be interested in maturing into something other than task-oriented engineers. Many firms have in-house training and mentoring programs that help younger engineers transition into becoming results-oriented engineers. For results-oriented engineers, it matters less how many hours they work than what results are achieved from that work. Measurable results might include new clients, profit, revenue, problem solving, good risk management, creative solutions, and whether a client is happy with your work.

This is a two-part article that identifies and describes sixteen key skill sets that engineers in a structural engineering practice should have in order to achieve results and make significant contributions to the firm. These skill sets follow two broad themes; technical and management. Part One covers the technical theme.

Each skill set starts with a set of questions to help you assess your overall maturity level for that particular shell. These are followed by suggested ways to improve within each skill set.

Familiarity with All Structural Project Types and Materials

Are you familiar with all of the project types that your firm normally works on? How many of these have you actually worked on? Are you familiar with all of the usual structural materials, like reinforced masonry and concrete, structural steel, light gage, post-tensioning, stick-framed wood and timber, engineered lumber, etc.? Are you familiar with all of the normal structural systems, like flat plates, pan slabs, pre-engineered metal building systems, composite steel, metal deck, steel joists and joist girders, retaining walls, etc.? Are you familiar with customary lateral force resisting systems like shearwalls, Eccentrically Braced Frames (EBF), Special Concentrically Braced Frames (SCBF), Special Moment Resisting Frames (SMRF), chords and collectors, etc? Are you familiar with various foundation systems and ground improvement techniques?

Improvement Tasks

- Review drawings of other project types that you have not worked on
- Ask questions
- Make it known that you would like to work on a certain building type or structural material that interests you or that you are not very experienced with
- Educate yourself by reading books, trade magazines, engineering journals, etc.
- Take classes and attend seminars
- Join a professional organization
- Be curious about other people's projects and discuss them together, even if you are not associated with that project
- Review drawings for projects prepared by other engineering firms whenever possible to see how other firms do things

Ability to Simplify a Problem

Do you know how to bracket a problem? How precise of an answer is required on a particular problem? Can you look at a problem and reduce it down to its simplest form? Can you recognize where a detailed analysis is required and where an approximate solution is good enough? How efficiently do you spend your time?

Improvement Tasks

- Learn to run quick hand calculations to check your work
- Know the answer by approximate methods before you model it in the computer
- When an exact answer is not required or achievable, simplify
- Learn to work fast and efficiently
- Know when to use software and when NOT to use software
- Use rules of thumb and short cuts whenever it makes sense

Completeness and Thoroughness of Drawings

How well are your drawings coordinated with other disciplines? Is there a "perfect" set of documents? How well do the general notes and specifications agree with the drawings? How well organized are your plans and details? How clear are your structural drawings to the end user? Do you know who the end users are? How complete is the information on your drawings and specifications? Will this project be reviewed by an outside party and does that affect the level of completeness?

Improvement Tasks

- A set of drawings that goes to the Principal for final review should represent the best possible and most complete effort on your part
- Make sure the general notes, specifications and drawings always agree
- Make sure your drawings follow common drafting rules and office standards
- Make sure drawings are well organized and appropriate for the project
- Discuss the drawing organization at the start of the project
- Determine if the project size or complexity warrants the need to over-do a set of drawings
- Read the American Institute of Steel Construction (AISC) *Code of Standard Practice* and the American Concrete Institute (ACI) *Detailing Manual*
- Review the drawings for constructability

Technical Skills

Are you conversant with all the computer software available in your office? How is your knowledge of Building Code requirements? Do you have a good understanding of structural analysis and design techniques? Are you familiar with all the various material codes? Do you have a detailed understanding of the basis for seismic loads, wind loads, snow loads, etc.? How much experience do you have with geotechnical issues? Are you familiar with all the various framing systems? Do you have a good inventory of rules of thumb?

Improvement Tasks

- Read and learn the International Building Code (IBC), the American Society of Civil Engineers (ASCE) codes and other similar building codes
- Be familiar with all material codes (AISC, ACI, National Wood Products Association, American Iron and Steel Institute, Steel Deck institute, Steel Joint Institute, etc.)
- Be familiar with American Society of Testing and Materials (ASTM)
- Learn about Factory Mutual (FM) requirements and Underwriters Labs (UL) assembly ratings
- When you review a geotechnical report, you should have an intimate understanding of all geotechnical aspects of the site. Read the geotechnical report AT LEAST three times
- Become familiar with all available structural engineering software in the office – go through the software guide and practice every program or go through every tutorial
- Take a class or two in areas in which you are weak or inexperienced

Writing Skills

Are you able to clearly and succinctly express a thought or technical concept in writing? Are your paragraphs and sentences grammatically correct? Is your writing professional and liability free? Are you as careful with emails as you are with other types of correspondence?

Improvement Tasks

- Read *The Business Writer's Handbook* (St. Martins Press) or *Handbook of Technical Writing* (St. Martins Press) or similar books on how to write
- Practice writing as often as you can
- Write correspondence and reports in third person active voice
- Read Design Professional Insurance Corporation's (DPIC) *Lessons in Liability* booklet to understand the problem with words like "all", "final", "inspect", "certify", "best", "worst" and scores of others.
- Read everything you write AT LEAST three times before you send it out to catch grammatical and syntax errors. Then read it again from the perspective of a lawyer, and then again from the perspective of the intended recipient.
- Try using the Oxford English Dictionary (OED) instead of MS Word's thesaurus

Quality and Organization of Calculations

Are your calculations neat and orderly, easy to follow, complete, and correct? Why do you perform calculations? Do you dive into the detailed beam design first thing on a project? Does your level of effort change if you know your calculations will be reviewed by an outside party? Do the calculations help the contractor? Should you save calculations after the project is constructed?

Improvement Tasks

- Organize calculations into sections such as foundations, floor framing, lateral analysis, etc.
- It is helpful to have a calculations index on larger projects
- Develop a written design criteria document tailored for each project so that you and all other engineers on the project work with the same parameters
- Imagine someone who did not work on the project having to read and understand your thought process by reading your calculations
- Cite conclusions in the calculations and indicate any assumptions made
- Cite references when appropriate
- Pay special attention to organization and completeness when you know the project will be reviewed out-of-house
- Remember that, although most building departments require structural calculations to be submitted for building permit, they are not part of the construction documents and are only used as a guide to assist in making engineering decisions
- Consider purging your files of the calculations when a job is complete as a part of your records retention policy

Desire to Learn New Things

Do you embrace new software? Do you view Building Information Modeling (BIM) as a hindrance or an advantage? Do you want to work with new materials and building types? Do you want to learn how the consulting business operates? Are you open to new structural systems? What are your thoughts on Integrated Project Delivery (IPD) and Design/Build (D/B) delivery?

Improvement Tasks

- Do not be afraid to use new software
- Take a class or two and go to seminars – continue your education
- Ask to review the office or company financials with one of the principals
- Take a leading role in the implementation of BIM in your office
- Become an expert in emerging technology or techniques

You may find it surprising that many of the architects, contractors, and building owners who hire structural engineers don't always know, or care, whether we're technically superior compared to the next engineer or another firm. They may take it for granted that all structural engineers have a similar level of technical ability. Having a command of the technical aspects of our profession is certainly essential and basic, but many of the consumers of our services value other skill sets, like our ability to make good decisions, our ability to take ownership, whether we embrace BIM and IPD, and our capability to understand a project from their point of view. In Part Two, we will explore a broad set of management skills that should be mastered to round out your ability to make a significant contribution to the success of your firm and achieve results.▪